ELECTRONIC DIGITAL COMPUTER

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SELECTION TESTS ON 3KP1 TYPE CATHODE RAY TUBES FOR A WILLIAMS MEMORY

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I INTRODUCTION

To provide a suitable number of properly operating cathode ray tubes for the Williams type memory to be used in the University of Illinois computer, a program of tube testing was set up. From previous experience in selecting tubes it was found that the percentage of tubes acceptable to tubes received of standard commercial 3KP1 type was from 25 to 35 percent. This report covers the testing of 139 cathode ray tubes, a sufficient number to acquire the 32 additional tubes needed to tube the machine.

II DESCRIPTION OF TEST

It was intended that the test should be conducted so that the tubes were operating under the same conditions as they would be expected to in use. Therefore, the regeneration amplifier and associated circuitry are identical to that which will be found in the completed memory. The tube voltages are the same. The control circuitry necessary to sequence the tests is not identical, but was so designed as to provide identical signals to the regeneration chassis and cathode ray tube as those in use in the computer.

The first test determines the ability of the tube to store information, at least on a short term basis, and tests the facility with which the machine may write into and read out of the memory. This is done by first adjusting for proper focus, astigmatism and intensity with the tube in the operating circuit. The output of the amplifier is used as the basis for making these adjustments. Then the external control is set to perform the reading and writing tests by holding a static pattern in half of the memory and continuously reading into and out of the other

half, reversing the contents of each spot each time. This type of operation is usually continued for a couple of minutes per tube to determine that it is generally operating quite well.

The main part of the test is done to ascertain a figure for the read-around-ratio and to note the presence of flaws. The read-around-ratio is here defined as the number of times a spot may be written into with a dash before the surrounding dots are so affected by refill that they are sensed as dashes. The control circuitry does this test by writing a dash into an address, which is selected by a set of 10 switches, for n times where n may be set from 1 through 1023. At the end of this bombardment, the entire raster is regenerated once and the bombardment regeneration sequence is repeated. The figure obtained for the read-around ratio is the maximum value of n for which no failures occur in the surrounding dots for a period of at least five seconds. In order that the 139 tubes might all be tested in a reasonable time, only four points were tested for their read-around-ratio. These points have the following coordinates where the first figure represents the horizontal coordinate on the 32 x 32 raster and the second represents the vertical coordinate. Positive directions are down and to the right from the upper left corner.

0, 8; 24, 8; 15, 15; 31, 31

The raster configuration is one in which odd columns are displaced downward one-half of a vertical address distance, alternate columns are twitched horizontally in opposite directions and the spacing between

[illegible]

[illegible]

[illegible]

alternate columns is adjusted so that failures occur with reasonably similar frequency to all the spots surrounding any one spot.

The test for the presence of flaws is done by filling the raster with dashes and allowing them to be stored statically while the raster is slowly moved through a one address horizontal and vertical television type scan so that all of the area of the used tube face is required to store a dash at some time. The presence of non-storing flaws will be noted after the scan by the presence of dots on the raster which have been caused by passing over flaws incapable of storing a dash. This does not indicate every spot which has a secondary emission ratio different from the average value on the screen, but it does indicate those spots which would cause trouble in use in the memory as it is built.

The criterion for the acceptance of a tube was that it have three or less non-storing flaws and have a read-around-ratio at the four selected spots of 50 or over. In a few cases, these conditions have been slightly violated in the case of read-around-ratio when the flaw count was very low. The exceptions probably will not be used in the completed memory but may be useful in an emergency.

III RESULTS OF THE TEST

Of the 139 tubes tested 73 were finally selected as being good enough to consider using in the completed memory. The remaining 66 were discarded for the following reasons; 29 for poor focus, 28 for having greater than three non-storing flaws, 7 for poor read-around-ratio, 1 for an intermittent open, and 1 for being excessively microphonic.

The figures for the good tubes selected are indicated in the attached table. It will be noted that 34 tubes have no non-storing flaws, 25 have only 1, 8 have 2 flaws, 6 have 3 flaws.

The four IBM tubes have been included as a comparison. It will be noted that none of these have any non-storing flaws and all have high read-around-ratios. It is also worth noting that the IBM tubes with P1 phosphor give lower output signals than the 3KP1's tested by at least 20%. The IBM X263 has a P5 phosphor and gives signals as large or larger than the standard 3KP1. The smaller signal in the P1 type IBM tubes is believed to result from the smaller beam size and the resulting lesser displacement of charge from the reduced spot. Apparently the P5 phosphor has a higher secondary emission ratio than the P1 type.

A word of caution should be injected about the apparently large read-around-ratios noted even among some of the 3KP1 tubes. Since these tests are conducted by bombarding a spot with a written-in dash and the dot pulse is not present during the bombardment, these figures might well be lowered somewhat if the test were run on a continuously read-in dash basis where the dot pulse is present since the beam is on longer per cycle under these conditions.

In any case, the 73 tubes accepted here should be sufficient to place the University of Illinois machine into operation.

GOOD TUBES

DESIGNATION

	RAR				
DESIGNATION	0,8	24,8	15,15	31,31	FLAWS
A	64	64	96	192	3
B	72	120	256	80	3
C	120	72	80	112	3
D	64	88	80	264	1
E	192	288	384	112	3
F	48	32	56	8	0
G	320	376	544	320	1
H	64	56	80	56	3
I	88	240	112	208	2
J	152	120	248	880	0
K	384	520	280	480	0
L	88	72	96	1008	0
M	248	504	246	248	2
N	144	176	128	192	1
O	120	640	888	1023	0
P	24	56	96	224	3
Q	32	96	56	248	2
R	352	96	16	768	0
S	96	128	240	40	0
T	96	224	480	128	1
U	112	128	160	192	2
V	216	200	208	80	0

GOOD TUBES CONTINUED

Design.	RAR				Flaws
W	96	224	184	88	0
X	120	260	128	512	0
Y	168	128	248	208	2
Z	312	264	376	248	2
AA	320	288	288	12	0
AB	488	312	496	1023	0
AC	16	24	32	216	0
AD	64	72	154	136	0
AE	32	32	80	48	0
AF	192	160	240	520	0
AG	120	224	120	112	2
AH	56	80	72	40	1
AI	192	112	160	224	1
AJ	376	384	384	892	0
AK	80	56	104	64	0
AL	352	80	144	192	1
AM	120	80	104	512	1
AN	64	144	192	160	1
AO	256	240	288	672	1
AP	88	96	128	552	0
AQ	240	192	224	112	1
AR	64	176	240	128	0
AS	224	192	224	640	0
AT	56	248	176	416	0
AU	120	312	128	512	0

GOOD TUBES CONTINUED

Design.	RAR				Flaws
AV	192	112	272	80	1
AW	56	64	56	144	1
AX	48	320	423	512	1
AY	112	160	168	284	1
AZ	224	352	240	512	0
BA	400	256	208	384	1
BB	16	136	256	128	1
BC	144	240	184	256	1
BD	192	696	368	464	2
BE	112	128	88	264	1
BF	56	248	280	144	0
BG	192	264	248	72	1
BH	232	264	248	248	0
BI	376	256	408	208	1
BJ	80	96	64	32	0
BK	120	184	304	528	1
BL	320	360	488	656	0
BM	224	192	352	480	0
BN	16	64	32	24	1
BO	144	288	144	20	0
BP	224	112	224	512	0
BQ	224	352	160	288	1
BR	92	96	96	128	0
BS	48	88	160	56	0

GOOD TUBES CONTINUED

Design.	RAR				Flaws
BT	208	472	446	446	0
EU	64	40	56	96	1
IBM X263	416	448	480	1023	0
IBM X300	416	416	224	480	0
IBM N28	416	384	1023	768	0
IBM N30	256	272	736	384	0